

REMARKS

Claims 1 to 26 are pending. No claims are allowed.

1. At the outset, the inventors would like to thank Examiners Lenwood Faulcon, Jr. and George Manuel for the time they took on November 29, 2005 to discuss the merits of the pending claims with their attorney. The substance of the interview is as set forth in the Interview Summary.

2. Claims 1 to 5 and 10 are rejected under 35 USC 103(a) as being unpatentable over Malonek et al. (U.S. Patent No. 6,292,704) in view of Lieber et al. (U.S. Pub. No. 2002/0117659). Malonek et al. teaches myocardial electrodes made from a substrate material, such as platinum-iridium, coated with an inert, high-capacitance material, such as iridium oxide, titanium nitride, pyrolytic carbon, and activated carbon.

As discussed in paragraph 0016, Lieber et al. generally relates to "a nanowire sensor device comprising a semiconductor nanowire and a binding partner having a specificity for a selected moiety. The nanowire has an exterior surface formed thereon to form a gate electrode. The nanowire also has a first end in electrical contact with a conductor to form a source electrode and a second end in contact with a conductor to form a drain electrode."

At paragraph 0062, it is described that the sensor device is made possible since "the nanowires are functionalized at their surface, or in close proximity to their surface. In one particular case, functionalization (e.g., with a reaction entity), either uniformly or non-uniformly, permits interaction of the functionalized

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nanowire with various entities, such as molecular entities, and the interaction induces a change in a property of the functionalized nanowire, which provides a mechanism for a nanoscale sensoring device."

Paragraph 0063 states that "a 'nanotube' is a nanowire that has a hollowed-out core . . ."

At paragraph 0064, Lieber et al. teach that "a nanowire or nanowires preferably forming part of a system constructed and arranged to determine an analyte in a sample to which the nanowire(s) is exposed. 'Determine', in this context, means to determine the quantity and/or presence of the analyte in the sample. Presence of the analyte can be determined by determining a change in a characteristic in the nanowire, typically an electrical characteristic or an optical characteristic. E.g. an analyte causes a detectable change in electrical conductivity of the nanowire or optical properties. In one embodiment, the nanowire includes, inherently, the ability to determine the analyte. The nanowire may be functionalized, i.e. comprising surface functional moieties, to which the analytes binds and induces a measurable property change to the nanowire." (Emphasis added.)

This binding is further described in paragraph 0068 as the "binding may be by one or more of a variety of mechanisms including, but not limited to ionic interactions, and/or covalent interactions, and/or hydrophobic interactions, and/or van der Waals interactions, etc." (Emphasis added.)

How the sensor is actually built is described at paragraph 0121 where "[a]ssembly, or controlled placement of nanowires on surfaces after growth can be carried out by

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aligning nanowires using an electrical field. An electrical field is generated between electrodes, nanowires are positioned between the electrodes (optionally flowed into a region between the electrodes in a suspending fluid), and will align in the electrical field and thereby can be made to span the distance between and contact each of the electrodes."

In that respect, Fig. 1 illustrates a nanoscale detector 10 comprised of a single nanowire 38 positioned above the upper surface 18 of substrate 16. A portion of the sidewall of the nanowire 38 is within the sample exposure region 30. Electrodes 36 connect the nanowire 38 to electrical connections 22 that, in turn, connect to a detector for measuring a change in an electrical or other property of the nanowire.

A specific embodiment is described in paragraph 0157 with respect to Fig. 16a. There, Lieber et al. teach that "the nanowire sensor of the invention comprises a single molecule of doped silicon 50. The doped silicon is shaped as a tube, and the doping can be n-doped or p-doped. Either way, the doped silicon nanowire forms a high resistance semiconductor material across which a voltage may be applied. The exterior surface and the interior surface of the tube will have an oxide formed thereon and the surface of the tube can act as the gate 52 of an FET device and the electrical contacts at either end of the tube allow the tube ends to acts as the drain 56 and the source 58. In the depicted embodiment the device is symmetric and either end of the device may be considered the drain or the source. For purpose of illustration, the nanowire of FIG. 16a defines the left-hand side as the source and the right hand side as the drain. FIG. 16a also

show that the nanowire device is disposed upon and electrically connected to two conductor elements 54 [at its sidewall adjacent to the ends connected to the drain 56 and source 58].” Finally, paragraph 0159 teaches that “[e]lements of interest within the sample can contact the surface of the nanowire device and, under certain conditions, bind or otherwise adhere to the surface.” (Emphasis added.”)

Therefore, the applicants are of the opinion that Lieber et al.’s sensor is in marked contrast to their presently claimed invention. For one, amended independent claim 1 sets forth that the electrode is implantable in direct contact with body tissue. Clearly, Lieber et al.’s nanosensor is not. It is a passive device in which the surface of the nanowire sidewall contacts a fluid flowing into the sample exposure region through the inlet where a measurement is taken before the fluid flows to an outlet. The measurement is taken as a result of an analyte in the fluid sample chemically reacting with a moiety at the surface of the nanowire sidewall. The chemical reaction at the sidewall surface can be ionic, covalent, hydrophobic, van der Waals, and the like, “to which the analytes binds and induces a measureable property change to the nanowire.” (See paragraph 0064.) If there is no detectable analyte in the sample, there is no chemical reaction with the nanowire sidewall and no measurable change. Nonetheless, the nanowire still functions as a sensor whether there is a measurable change, or not. The existence or lack thereof of a measurable change is by the nanowire making up part of a circuit with the source and drain electrodes electrically connected to the opposed end thereof.

In contrast, the nanotubes of the Applicants' claimed invention each comprise a length between first and second ends. Substantial numbers of them are covalently bonded at only their first end to a biocompatible and electrically conductive coating provided on a substrate. An example is the spiky carbon whisker structures discussed at page 7, lines 9 to 15 and shown in Figs. 2A and 2B. However, as described in the specification at page 3, lines 12 to 30, there are also nanotubes covalently bonded to the substrate at both their first and second ends. Regardless, a free portion of the nanotubes exhibiting relatively low polarization (page 4, lines 3 to 5) with respect to the covalently bonded end or ends is directly contactable by body tissue with electrical energy being transferable through the substrate, the conductive catalyzing coating and the multiplicity of nanotubes in a low energy loss manner (page 1, lines 7 to 22) suitable for an implantable electrode.

That the end or ends of the Applicants' nanotubes are covalently bonded to the catalyzing coating on the substrate is markedly different than having a nanowire connected to source and drain contacts at its opposed ends. In Lieber et al., the opposed ends of the nanowire connected to electrode contacts complete a circuit for taking a measurement of an analyte binding to the exposed surface of the wire. In the presently claimed invention, there is no binding at the surface of the nanotube. Instead, the exposed portions of the nanotube not covalently bonded to the catalyzing coating on the substrate serve as surfaces from which electrical charge can be moved to a body tissue.

Accordingly, amended independent claim 1 is patentable over this combination of patent references. Claims 2 to 5 and 10 are allowable as hinging from a patentable base claim.

Reconsideration of this rejection is requested.

3. Claims 6, 7, 14 to 19, 25 and 26 are rejected under 35 USC 103(a) as being unpatentable over Malonek et al. in view of Lieber et al. as applied to claims 1 to 5 and 10 above, and further in view of Smalley et al. (U.S. Pub. No. 2002/0085968). Smalley et al. describes a method for producing single-walled carbon nanotubes by supplying carbon vapor to the "live end" of a carbon nanotube maintained in an annealing zone. The live end is where the one or more Group VI or VIII transition metals serving as catalysts are located. Then, the carbon nanotubes grow in length by the catalytic addition of carbon from the vapor to the live ends. This is described in paragraph 0067.

As discussed in section 2 above, presently amended independent claim 1 is believed to be patentable over the Lieber et al. reference. Accordingly, claims 6 and 7 are allowable as depending from a patentable base claim. Independent claims 14 and 25 have been amended in a similar manner. Therefore, claims 15 to 19 and 25 are likewise allowable as hinging from patentable base claims.

Reconsideration of this rejection is requested.

4. Claims 8, 9, 11 to 13 and 20 to 24 are rejected under 35 USC 103(a) as being unpatentable over Malonek et al. in view of Lieber et al. as applied to claims 1 to 7, 10, 14, 15, 18, 19, 25 and 26 above, and further in view of Croci et al. (U.S. Pub. No. 2004/0151835). Croci et al. relates

to coating carbon nanotubes on a substrate for the manufacture of an election-emitting cathode for a luminescent tube. The surface of a substrate is coated with a catalytic substance, for example a salt of iron, nickel or cobalt. If desired, a layer of titanium is deposited on the substrate to enhance catalyst adhesion. Carbon monoxide, acetylene, methane, ethylene, butane, benzene, and mixtures thereof are suitable carbonaceous compounds that can be decomposed to give carbon nanotubes. The growth of nanotubes is then carried out under a gas stream or under a static atmosphere with the substrate heated to about 300°C to about 1,500°C. Passing an electric current through the conductive substrate preferably does the heating. In Fig. 1, the substrate is shown as a wire 5 coated over its entire surface by a layer 6 of carbon nanotubes.

Again, claims 8 and 9 are allowable as depending from a patentable base claim 1. Independent claims 11 and 20 have been amended in a similar manner as independent claim 1. Therefore, claims 12, 13 and 21 to 24 are likewise allowable as hinging from patentable base claims.

Reconsideration of this rejection is requested.

5. The prior art made of record and not relied upon has been reviewed. However, it is not believed to be more pertinent to the Applicants' presently claimed invention than the above discussed patent references.

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It is believed that claims 1 to 26 are now in condition for allowance. Notice of Allowance is requested.

Respectfully submitted,



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December 20, 2005